LASERS & LASER PROTECTION

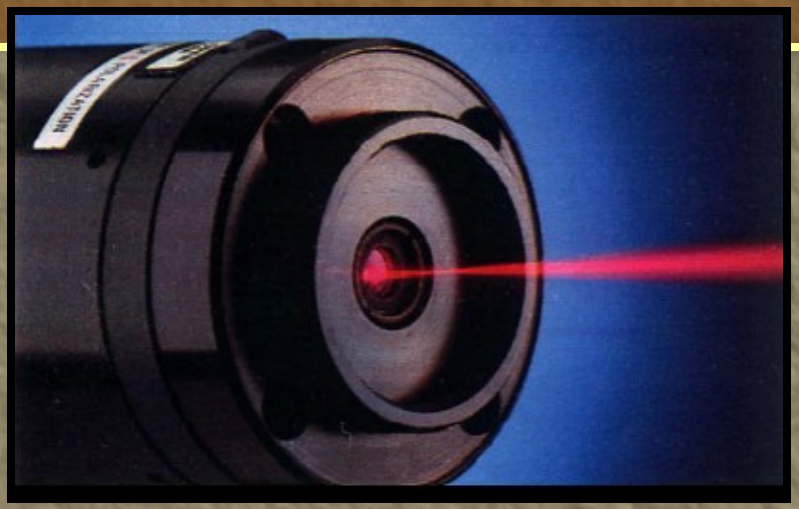
Objectives

1. Describe military uses for lasers
2. Describe the four laser classifications
3. Describe laser effects on the eye and skin
4. Identify the two goals of laser eye protection
5. Identify the shortfalls of laser eye protection

Lasers & Laser Protection

Definition

- Laser:
  - Light Amplification by Stimulated Emission of Radiation
  - A device that emits a highly-focused, single-wavelength beam of light
    - Its brightness can exceed that of all known natural sources



Military Uses of Lasers

- Range Finding
- Target Designation
- Medical and Research
- Training
- Weapons
  - Damage enemy optical sensors and electronic equipment
  - Antipersonnel
    - Produce transient or permanent vision loss

Laser Classifications (ANSI Z 136.1 - 1993)

- **Class 1**
  - Intrinsically safe / No risk
  - No user precautions are required; no warning labels are necessary.
  - Example: grocery store scanne

Laser Classifications (ANSI Z 136.1 - 1993)

- **Class 2**
  - Low power / Low risk
  - Powerful enough to cause eye injury (but not to the skin) if the beam is deliberately viewed.
  - Blink reflexes will normally prevent injury.
  - A **Caution Label** is required.
  - Examples: laser pointers and construction l

Laser Classifications (ANSI Z 136.1 - 1993)

- **Class 3A**
  - More powerful than Class 2, but are more spread out. Unmodified beams give no greater risk than Class 2.
  - Concentrated beams (for example by viewing it through binoculars) can cause injury in less than 0.25 seconds, the normal response time for blink reflexes.
  - A **Caution Label** is required.
  - Examples: laser pointers, and medical treatment a research lasers

Laser Classifications (ANSI Z 136.1 - 1993)

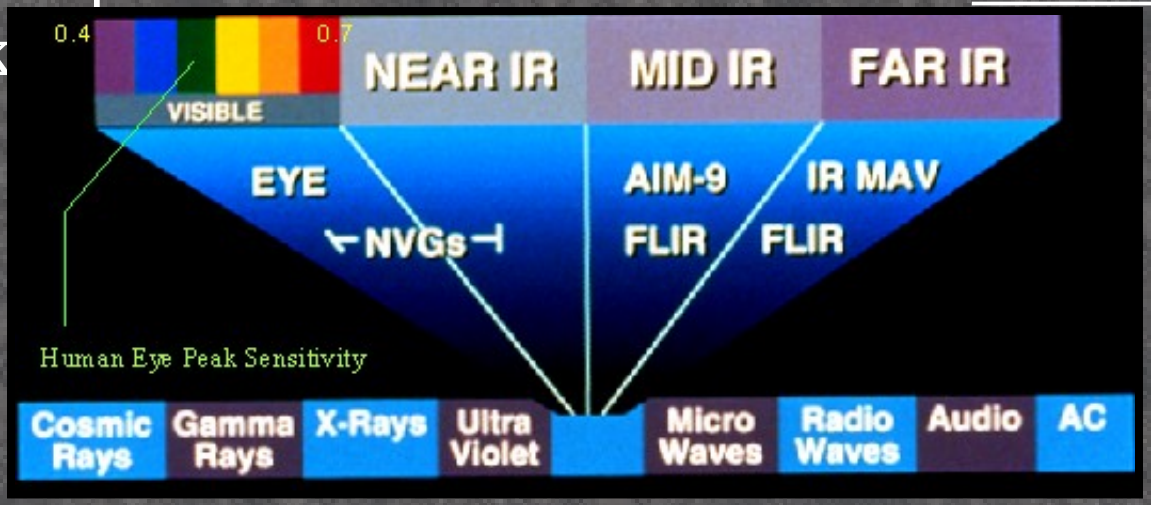
- **Class 3B**
  - Medium power / Medium risk
  - Capable of causing eye injury; blink reflexe are too slow to respond.
  - A **Danger Label** is required.
  - Examples: weapon systems, and medical treatment and research lasers

Laser Classifications (ANSI Z 136.1 - 1993)

- **Class 4**
  - High power / High risk
  - Capable of causing skin injury; skin covering recommended
  - Will instantly cause severe ocular injury (and possibly blindness). Even viewing beam reflections can cause eye injury.
  - Can cause combustion
  - A **Danger Label** is required.
  - Examples: weapon systems, medical

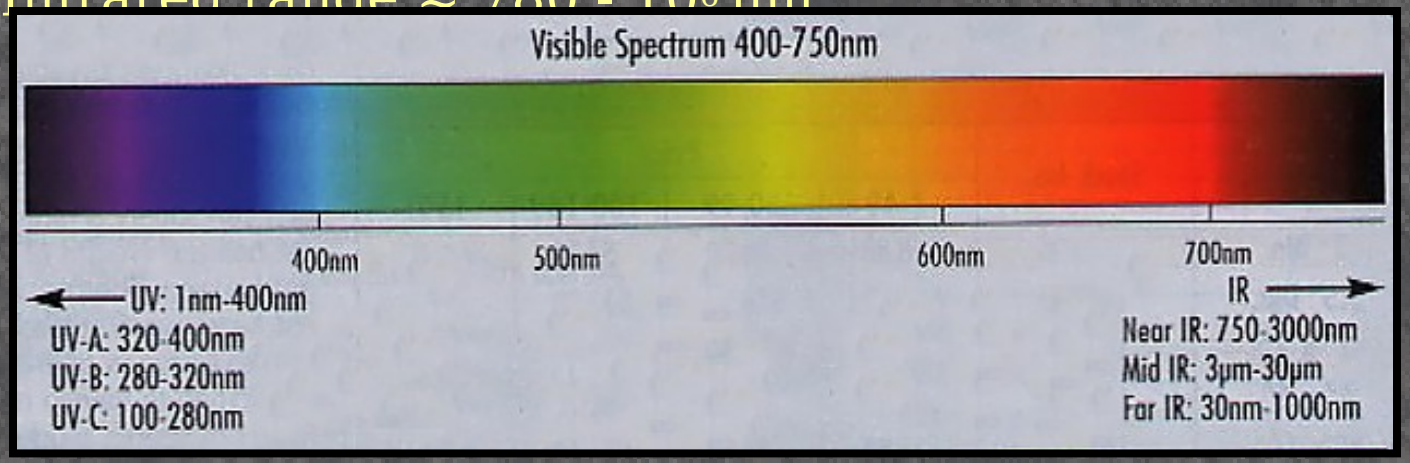
Laser Light

- Visible light forms just a small portion of the electromagnetic spectrum. Some laser beams fall within this visible spectrum.
- Some laser beams fall into the ultraviolet or infrared spectrum. These beams are invisible to the nak



Laser Light

- The unit of light wavelength (color) is the nanometer
  - 1 nm = 1/1,000,000 millimeter
  - Ultraviolet range ≈ 100 - 380 nm
  - Visible range ≈ 390 - 780 nm
  - Infrared range ≈ 780 - 10^6 nm



Laser Light

- Most lasers produce beams of one wavelength only…
  - Argon Ion 488 nm (green)
  - HeNe 543 nm (yellow-green)
  - Ruby* 694 nm (red)
  - GaAs* 850 / 905 nm (invisible - infrared)
  - Nd:YAG* 1064 nm (invisible - infrared)

  *Used extensively by the military

- FYI: There will be “agile” lasers in the near future that can actively change their beam wavelength.

Laser Damage

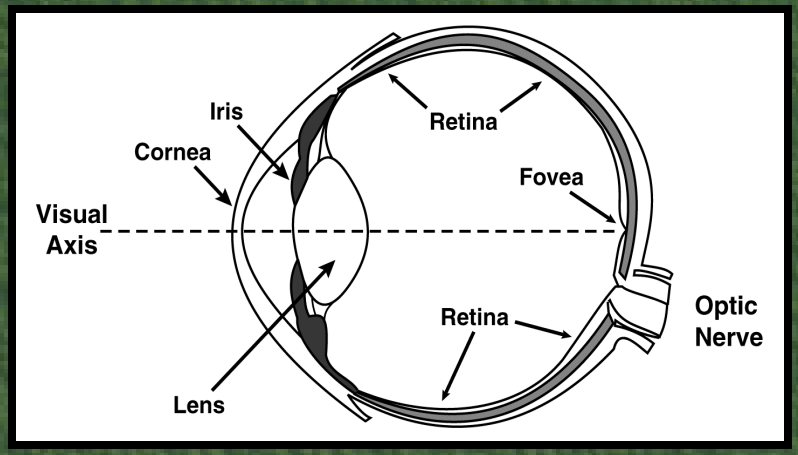
- Both visible and invisible laser beams can cause bodily injury.
  - This damage can be temporary or permanent
  - The **eyes** and **skin** are the most susceptible areas
- The skin is most sensitive to ultraviolet and infrared wavelengths.
  - The result can be a “burn” or an increased chance of skin cancer

Laser Damage

- Ocular injuries from lasers are the largest concern.
  - The eye's optics *greatly* concentrate the laser beam
- Lasers can affect the eye by…
  - Producing glare / obscuring dim lights
  - Interfering with dark adaptation
  - Inducing flashblindness and afterima
  - Causing temporary or permanent visi
    - Usually bilateral
    - Can be painless or painful

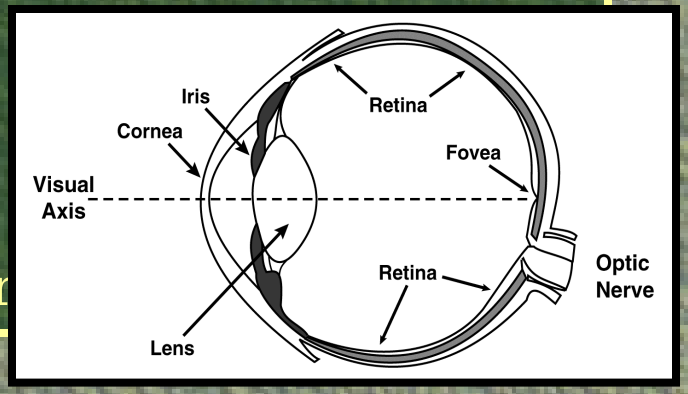
Laser Damage

- The eyelid, like other skin, absorbs ultraviolet and infrared light. The cornea and lens absorb wavelengths above 1300 nm (far infrared). Lasers operating over these wavelengths can produce damage:
  - Eyelid “sunburns” or thermal
  - Corneal burns and scars
  - Cataracts



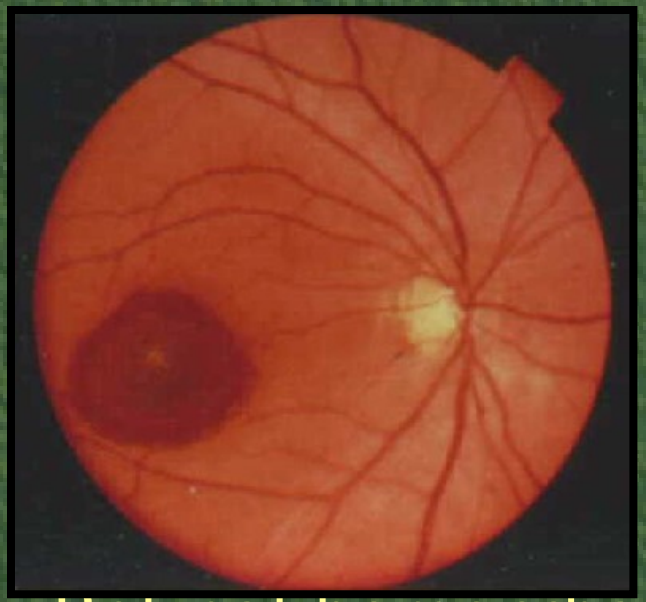
Laser Damage

- The retina is exposed to wavelengths between ~390 and 1300 nm (visible and near infrared)
- The eye's optics collect and concentrate laser beams onto the retina. This can produce damage:
  - Thermal or photochemical retinal injury
  - Sub-retinal burns
  - Blood vessel hemorrhages
- This injury can be painless…
  - There are no pain fibers in the r



Laser Damage

Healthy retina



Retinal hemorrhage and burn

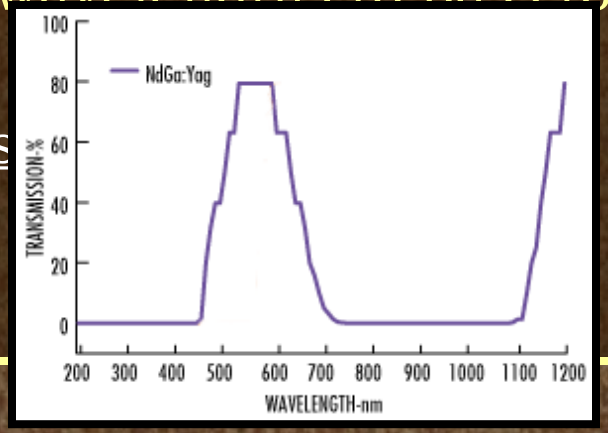
(secondary to Nd:YAG laser exposure)

Laser Eye Protection

- Laser eye protection (LEP) comes in many forms
  - Goggles, spectacles, visors…
- LEP must be appropriate to the specific laser being used
  - Appropriate to its wavelength and power output
- Lenses must be marked with wavelength and optical density
- 093 is the applicable stan

Laser Eye Protection

- At present, LEPs use one of two techniques:
  - (1) Reflective technology
  - (2) Filtering lenses
- There are two overall goals in LEP:
  - Block (or reflect) the laser beam wavelength so it doesn't reach the eye
  - Allow a maximum number of visible wavelengths to pass to the eye
    - Remember…"more light is more s



Laser Eye Protection

- Older LEP designs provide protection against one wavelength
- Newer technology allows for multiple wavelength protection
- Unfortunately, LEPs are not perfect…
  - A range of useful wavelengths can also be blo
    - May slightly degrade daytime vision
    - May greatly degrade night vision
      - (like wearing sunglasses at night)
  - Colors can appear distorted
  - One LEP cannot protect you from all laser thr

Laser Eye Protection - Practicalities

- When the threat wavelength is known, wear specific protection.
- When the laser threat is unknown, wear multi-wavelength protection.

- At night, the pupil dilates…
  - This increases the chance of internal eye damage from lasers.
  - Make sure to wear the appropriate LEP!

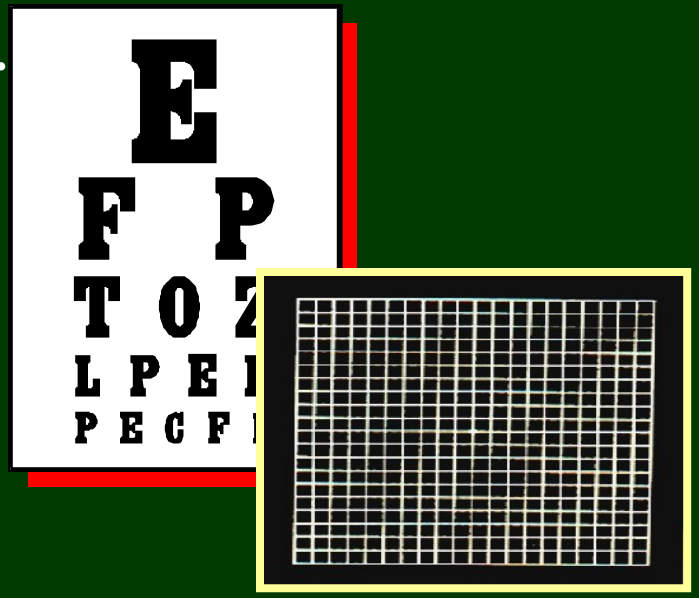
- Never fixate on any target with laser-use potential…
  look to one side of it.
  - This minimizes the possibility of a central retinal burn
    and complete central vision loss.

Laser Eye Protection - Practicalities

- Night Vision Goggles:
  - Some NVGs will provide laser eye protection, some will not.
    - Consult with your AMSO about your specific NVGs
  - Be prepared: lasers can easily produce temporary flashblindness through NVGs
- If you are exposed to a laser beam, and cannot close both eyes (e.g., while flying an aircraft)…try to close one eye
  - This will help to prevent complete vision loss via bilateral flashblindness or eye injury.

Ocular Laser Overexposure

- Suspected laser overexposures require **IMMEDIATE** action!
- Seek medical attention…
  - Ocular history
  - Distance visual acuity
  - Color vision
  - Amsler grid
  - Slit lamp exam
  - Dilated retinal exam
  - Retinal photograph



Ocular Laser Overexposure

- Contact one or more of the following ASAP:
  - Tri-Service Laser Incident Hotline (800-473-3549)
    - laser.safety@brooks.af.mil
  - The TVCR Team at USACHPPM (410-436-2714)
    - laserincident@amedd.army.mil
  - The Laser Branch at USACHPPM (410-436-3932)
    - laserincident@amedd.army.mil
  - CHPPM-EUR (DSN: 486-8545)

Questions?

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- **Thank you** to the following for supplying information and figures:
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